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Prospective Science Teachers' Problem-solving Skills through Science-integrated Learning

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Abstract

Problem-solving skills require an integrated understanding of the data, facts, and scientific theories being studied. Prospective teachers need problem-solving skills so that their way of thinking becomes more critical and analytical. This study aims to measure prospective science teachers' problem-solving skills after applying the science-integrated learning model. This study uses a mixed method. Quantitative data in this study were obtained from the test results measuring problem-solving skills. Qualitative data were obtained from exploring the test results through in-depth interviews with respondents. Prospective science teachers have excellent problem-solving skills. The average score is 86, the highest score is 92, and the lowest score is 80. Most students get a score >85, and there are no students who score below 80. This study concludes that problem-solving skills are measured from various prospective science teachers' learning outcomes through practicum, discussion, and assignments.

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INTRODUCTION

Thinking critically, logically, and systematically are basic skills that prospective science teachers must possess. Critical thinking is related to the analysis of various facts to solve problems. The object of scientific study can be logically carried out through systematic scientific procedures. Thinking skills are needed to solve various scientific problems, which occur factually with the support of data and facts. Thinking skills can develop through various stimuli presenting real-life problems (Spector & Ma, 2019; Atit et al., 2020; Wale & Bishaw, 2020). The stimulus can be in the form of problems related to the misconception of science or the application of science in society. Facilities from lecturers through learning activities that apply a participatory approach with factual study objects can encourage students to develop logical thinking skills. The more skilled students are in connecting data with facts, the better their analytical skills will be so that they can solve problems (Hartmann et al., 2021; Oh, 2022).

The problem-solving skills analyzed from the initial study of this research show that prospective science teachers have difficulty solving problems that require the integration of concepts. The integration of concepts in science needs to be explained by presenting various examples of the application of science in real life (Ross, 2019; Arık & Topçu, 2022). This finding is reinforced by data from the analysis of test answers for higher-order thinking questions. Data shows that less than 45% of students can correctly answer questions requiring relationships between concepts in science. The ability to integrate analysis between concepts to solve problems is still weak. The insufficient ability to integrate between concepts impacts the lack of ability to solve problems (Cejudo & Michel, 2017). Prospective science teachers who are weak in problem-solving are feared to impact the facilitation of students' learning in schools.

Science problems can be complex or cannot be solved using certain concepts. Various scientific concepts are connected to identify and find solutions to a problem. Relating the understanding of one concept to another can form analytical thinking skills. The stimulus of a problem can be used to relate one concept to another in science (Anderson et al., 2014; Meagher et al., 2018). Problem-solving skills can measure the depth and breadth of concept mastery. The deeper one's mastery of scientific concepts, the better one's skills to criticize an object scientifically (Saçkes et al., 2020). Being critical in science learning requires integration between data and facts. Each data obtained is associated with facts. Inaccurate data is why solutions cannot be generated. Weak facts are why the logic in taking solutions is not strong. The integration between data, facts, and concepts makes understanding science not only a theory but also an application. Problem-solving in science begins with understanding the problem. The source of the problem needs to be analyzed to produce various data and facts. The problem-solving plan becomes the stage after understanding the problem. The plan is in the form of a strategy to solve the problem.

Prospective science teachers' problem-solving skills need to be researched to get accurate information about their readiness to become professional science teachers. Problem-solving is a measure of concept mastery as a learning outcome (Kim, & Roth, 2016; Song, 2018; Wen et al., 2018). This study's results become input for prospective science teachers' preparation. In-depth and broad concept mastery and critical thinking skills help students solve various scientific problems.

The analysis of various studies on problem-solving skills in science learning further reinforces the urgency to provide this knowledge to prospective science teachers. Problem-solving skills are determined by skills in analyzing facts and data from a phenomenon in science (Aslan & Duruhan, 2021). The more complete the data, the stronger the conclusions. Problem-solving skills are not limited to answering correctly but also explaining the cause and effect of an event (Malik & Mathew, 2019). Scientific truth is universal, so the solution to a problem has a broad truth. Problem-solving skills are trained using learning strategies that have stages of learning to find solutions to problems (Servant, 2019). The choice of strategy is related to how to make choices to solve problems. The more strategies are mastered, the more opportunities are open to solving problems in an integrated manner.

Integrating concepts in science is an integral part of the science-integrated learning model. This model has complete learning stages starting from exploration, concept integration, formulating problems, experimentation, analysis, conclusions, and reflection (Parmin et al., 2017). This study aims to measure prospective science teachers' problem-solving skills after applying the science-integrated learning model in learning. Problem-solving skills were measured to obtain complete information about the impact of the learning carried out. Problem-solving skills are

used as an indicator of prospective science teachers' skills to think critically, logically, and systematically. The science-integrated learning model is used because it has the learning stage to do scientific testing through practicums.

METHOD

This study uses a mixed method (Creswell, 2014). Quantitative data in this study were obtained from the test results measuring problem-solving skills. Qualitative data were obtained from exploring the test results through in-depth interviews with respondents. The research targets are prospective science teachers attending systematics of living things courses. This course was chosen as the study material because it has a scientific study that integrates various science concepts. The integration in this course material is in the form of natural materials with living things and between living things. The research targets were 42 prospective science teachers, 11 males and 31 females. The target characteristics are still in the same semester and attending the same various prerequisite courses.

The data collected is test score data. Test questions are used to measure problem-solving skills. Test questions are used to measure problem-solving skills. The indicator of solving the problem is when students answer correctly. Indicators of solving problems in this study are students can understand the problem, develop strategies to solve problems, solve problems, and re-examine answers.

The problem-solving skills referred to in the study are correctly answering questions that ask problems in applying the systematic concept of living things. There are 20 multiple-choice questions. All questions stimulate various problems, which are presented in tables, graphs, pictures, and descriptions of scientific phenomena. Before use, the content of the questions was validated by learning evaluation experts and tested limited to students. Expert validation is carried out to ensure that the questions meet the problem-solving criteria referred to in this study. Testing questions on students who have completed this course is carried out to test the readability of the questions.

The test results were explored through interviews with all students. Interviews were written by asking open-ended questions to explore prospective science teachers' problem-solving skills. The test result data was analyzed by counting the number of students who correctly and incorrectly answered each item. Average test scores, highest test scores, and lowest test scores were also calculated. Some of the questions answered correctly and incorrectly by students were analyzed using the results of interviews. The data from the interviews were analyzed qualitatively to find the difficulty in answering the questions. The test results are linked to interview data strengthened by facts during the learning process.

RESULT AND DISCUSSION

The test results used to measure problem-solving skills are listed in Table 1.

Table 1. Result of Systematics of Living Things Test

Total Students	Score Range	Number of Students
42	< 60	0
	60 – 79	0
	80 – 85	9
	> 85	23

From the test results, prospective science teachers have excellent problem-solving skills. The average score is 86, the highest score is 92, and the lowest score is 80. Most students get a score >85, and there are no students who score below 80. The results of the analysis of the most items answered correctly and incorrectly are in Figure 1.

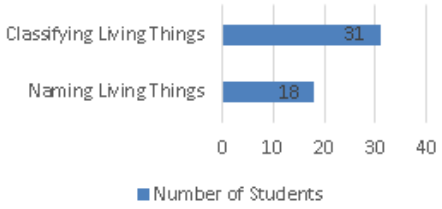

Figure 1. Most Correctly and Incorrectly Answered Questions

The integration between the characteristics of living things and naming is the most difficult for students because only 18 students answered correctly, while classifying living things is the easiest because 31 students answered correctly. The test results data and analysis of test items were followed up by interviews with students. The interview results are in Table 2.

The interview results show that the pro-

spective science teachers are interested in the stimulus in the questions. All the stimuli are related to the systematics of living things during learning. Stimulus is in the form of tables, pictures, graphs, and stories from the results of practicum and discussion during learning.

Table 2. Results of Interview with Prospective Science Teachers

Question	Answer
Are you interested in questions with a stimulus?	Yes, I am interested.
Why are you interested in questions with a stimulus?	Because the questions with the stimulus are easier to understand because they have tables, pictures, graphs, or stories, we try to understand the stimulus before working on the question.
Did you have difficulty answering the questions?	No, because the language is easy to understand with an attraction in the form of a stimulus.
Did you find scientific integration in each question?	Yes, because each question clearly states that there are at least two concepts in the systematics of living things
Do you feel that you can answer the questions correctly?	Yes, I do.

Prospective science teachers' problem-solving skills in this study were measured by various learning outcomes. Learning activities in the form of online practicums, discussions, and assignments are used as a stimulus in the test questions. Discussions about various problems are carried out when students carry out learning activities. Problem-solving is done through practicum, discussion, and assignment activities so that students have direct experience in learning to solve problems. Problem-solving skills during science learning can be trained through various scientific activities (Akben, 2020 & Erol, 2022). Sources of problems need to be introduced to students so that efforts to find solutions are more focused. Problem-solving can be trained by repeating the activities carried out so that students have variations in determining solutions. When the problem about the concept comes from students, there is a stronger urge to find a solution.

From the findings of this study, problem-solving skills can be measured using test questions. Each test item used has a particular specification: stimulus. Questions with a stimulus do not use direct interrogative sentences but have an introduction in the form of data, facts, and information which, if understood properly, will increase the chances of answering correctly. The stimulus used comes from learning activities, so no stimulus has not been studied. The ability to answer test questions is determined by the learning experience (Brauer & Wilde, 2018). If the question comes from the learning activities, then the potential for answering correctly is even more significant. In contrast, if the question is not related to learning activities, the chances of answering correctly are smaller. The success of learning science is measured through various learning achievements. Prospective science teachers' problem-solving skills in this study were very good. Learning outcomes in the form of practicum data, facts from discussions, and assignment products with the science-integrated learning model stages are used as a stimulus for questions.

The science-integrated learning model in the learning of systematic of living things has a high level of conformity because the learning stages are under the characteristics of the material. Exploration activities provide a learning experience to find various sources of information from electronic media. Practicum activities that begin with identifying problems provide a meaningful learning experience for students. This model has the power of scientific testing by students through practicum activities. Practicum is a great way to find answers in science (Melville et al., 2014 & Tsybulsky et al., 2021). Students learn to solve problems using data from the practicum results. The data obtained is integrated with various facts so that the integration between sources of information can be used as a reference in determining conclusions. The power of learning science from concept mastery is applied in practicums.

This study further strengthens the importance of choosing the correct learning strategy by analyzing the studied material characteristics. Problem-solving skills are complex because they involve higher-order thinking skills that require understanding data and facts. Complete integration of science needs to be reviewed from concepts, data, and facts. Problem-solving based on mastery of data and facts strengthens the concepts learned. Prospective science teachers skilled at solving problems must be prepared with learning experiences from practicum, observa-

tion, discussion, and assignments. Measurement of problem-solving skills is done by utilizing the results of the learning experience.

CONCLUSION

Problem-solving skills are measured from various prospective science teachers' learning outcomes through practicum, discussion, and assignments. Learning that trains problem-solving skills produces various data and facts to strengthen understanding of scientific theory. Before the prospective science teachers' problem-solving skills are measured, they need to be given a learning experience to practice solving various scientific problems. The strategies in this study can be used on other students in different courses. Prospective teachers skilled in solving problems make their way of thinking more critical, logical, and systematic.

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